Santa Clara River Steelhead
Restoration Assessment

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Overview

The Santa Clara River steelhead is one of the last remaining southern California steelhead stocks. Southern California steelhead have adapted to generally arid conditions and, therefore, are a unique genetic resource.

In recent decades the Santa Clara steelhead run has diminished to a remnant level. The suspected major cause is adult and juvenile transportation problems due to diversion dam construction in the lower Santa Clara mainstem. The latest in this series of dams (the Vern Freeman Diversion) includes fish transportation facilities. This offers promise of improved steelhead survival and possible run rebuilding.

Uncertainty about run size and additional factors that potentially cause extreme steelhead mortality, argues for an aggressive restoration effort. FWS mandates to restore nationally significant depressed fish and to increase fishing opportunity suggests a FWS interest in restoring this stock.

Background

The Santa Clara River is the largest river system in Southern California. It is located in Ventura and Los Angeles Counties and enters the Pacific Ocean just south of the city of Ventura. Much of The Santa Clara watershed lies in the Los Padres National Forest, the Angeles National Forest, and the Sespe Condor Sanctuary.

Historically the Santa Clara system supported a substantial steelhead run. The run size and life history of this stock is not known precisely. Detailed assessments of historical catches, spawning escapement, etc. are not currently available. Moore (1980) uses a comparison with Matilija Creek, in the upper Ventura River system, to produce a rough historical run size estimate of about 9000 fish.

Historically the spawning and rearing habitat in the Santa Clara system was located primarily in three tributaries; Santa Paula, Sespe, and Piru Creeks. Sespe is the largest of these. Moore (1980) states that Sespe historically contained 53 miles of habitat, whereas Santa Paula contained 11 and Piru about 25.

The Santa Clara mainstem was used for transport of adults and juveniles between the ocean and upstream habitat. Since the Santa Clara mainstem is dry for much of the year, the steelhead stock adapted migration behavior to utilize the winter freshets that provided adequate flows in the mainstem.

Current Status of the Santa Clara System

The most significant changes to the steelhead environment have resulted from dam construction. Dams have obstructed steelhead migration and have eliminated spawning and rearing habitat.

Obstruction to adult and juvenile migration through the lower Santa Clara mainstem is thought to be the most damaging result of dam construction. Obstructions consist of a physical barrier, in the form of a diversion dam in the lower Santa Clara river, and a general lowering of mainstem flows due to water storage in the upper watershed.

Since 1928 there has been a diversion dam at approximately river mile 10 in the lower Santa Clara River. The dam is used to divert water to percolation basins. Until recently the dam consisted of an earthen dike which would divert the entire flow until dam capacity was exceeded. After this the dam would breach allowing water to pass to the ocean. Effective adult and juvenile migration could occur only when the dam was breached. The current dam (the Vern Freeman Diversion) was completed in 1991. It is a permanent concrete structure and includes mechanisms for both adult and juvenile passage.

From 1954 to 1991 the diversion dams also obstructed migration by diverting juveniles and spawned adults into the percolation basin intake. During other years, fish exclusion screens were installed to prevent this. The current dam has screened intakes.

Reduction of mainstem flows has resulted from construction of three water storage dams in the upper watershed; San Felicia and Pyramid dams on Piru Creek, and Castaic in the extreme upper watershed, on Castaic Creek. Historic mainstem flow patterns were not documented so flow reductions from dam construction are difficult to determine. A proposal to transport water from Pyramid Lake to the Santa Clara mainstem has the potential of restoring some of the lost flow (Gross, 1990).

Beyond mainstem transportation problems, dam construction resulted in loss of habitat in Piru and Santa Paula Creeks. The San Felicia Dam blocked adult passage to most of Piru Creek in 1955. Flow changes resulting from operation of San Felicia dam and Pyramid dam, constructed in 1973, eliminated the spawning and rearing habitat in the accessible sections of lower Piru Creek.

An old, obsolete, diversion dam in Santa Paula Creek, located 2 miles from the Santa Clara confluence, blocks adult passage. Although somewhat developed, Santa Paula Creek still contains good spawning and rearing habitat. Elimination of the adult passage problem, at the old diversion dam, could restore production to about 10 miles of habitat.

Of the major spawning and rearing areas in the Santa Clara system only Sespe Creek remains largely undeveloped. Sespe remains undammed and historical steelhead habitat remains in near pristine condition. Sespe Creek lies within the Los Padres National Forest and runs through the Sespe Condor Sanctuary.

Other impacts to the Santa Clara River system include stream channelization, point and nonpoint source pollution, and gravel removal. These impacts are thought to have relatively less impact on steelhead survival.

Status of the Steelhead Stock

There is very little information on which to base a current run size estimate for Santa Clara steelhead. There have been no recent systematic surveys for adults or juveniles. Clearly, however, the run is extremely depressed. There have been few recent observations. During a 1982 to 1984 survey 3 adult steelhead were observed in the Santa Clara system (Puckett and Villa, 1984). In 1987 and 1988 several adult steelhead were observed by U.S. Fish and Wildlife Service personnel in lower Santa Paula Creek (Kaufman 1989).

Alternatively, it is doubtful that the stock is extinct. The presence of steelhead during 1987 and 1988 indicates that adult migration occurred, at some level, during recent drought years. The lack of recent observations does not imply extinction because a small remnant run would not likely be observed incidentally.

The new Vern Freeman Diversion has facilities for counting adults. Beginning in the winter of 1992-93 accurate enumerations of run size should be available.

Restoration Concepts

Restoration is required when environmental conditions and/or exploitation patterns result in increased mortality rates and run size becomes diminished. Ideally, the restoration effort would identify and correct the cause of increased mortality and allow the stock to rebuild naturally, requiring no artificial propagation. This ideal is rarely realized, however, and artificial propagation is often required. Usually the effectiveness of efforts to improve environmental conditions are difficult to predict. If such uncertainties are compounded by concerns about a critically low run size, artificial propagation may be used to minimize the near term chance of extinction. If adverse environmental conditions cannot be corrected, artificial propagation may be required in the long term.

Attitudes and professional opinions toward artificial propagation continue to be debated and are evolving. Historically, artificial propagation often consisted of long term hatchery programs. Hatcheries increase the egg to fry survival rate from roughly 5% to around 90%. This substantial boost in survival has proven effective in restoration. In addition, hatcheries can produce large numbers of fish economically. Together, these features have made hatcheries an attractive restoration tool. However, genetic conservation concerns have caused a re-evaluation of highly manipulative forms of artificial propagation such as hatcheries (Reisenbichler and McIntyre 1977, Chilcote et. al. 1986, and Helle 1976). There is some evidence that hatchery rearing substantially modifies genetic development. Less manipulative forms of artificial propagation such as instream egg incubators are favored for genetic conservation, but may not provide the needed increase in survival or the necessary volume of production.

Selection of a method of artificial restoration requires a tradeoff between potential genetic manipulation and risk of stock extinction. Minimally manipulative methods are favored when feasible but prevention of extinction must remain the highest priority.

Assessment of Limits to Steelhead Survival

Determination of restoration need, restoration feasibility, and the appropriate use of artificial propagation requires a careful assessment of the limits to survival of Santa Clara steelhead:

Adult Migration Barriers

In recent decades, adult migration has been hindered by the intermittent flow in the extreme lower Santa Clara mainstem and generally low flows in other parts of the mainstem. Steelhead were required to hold in salt water until flow levels were sufficient to breach the lower river diversion dam. After passing the breached diversion dam, steelhead were required to migrate to spawning grounds through flow levels that were limited by upper watershed storage dams.

The Vern Freeman Diversion, constructed in 1991, provides improved conditions for adult migration. A fish ladder has been installed to provide passage throughout the migratory period. The ladder has not yet been tested for efficiency of passage, but it appears to have been adequately designed.

Potential adult migration problems caused by low flows in the mainstem have not been investigated. Conceivably lowering of flows caused by dam storage could trap adults in the mainstem, preventing passage to spawning areas. Barriers should occur only during low or moderate flow levels, however. Higher flow levels can be expected to provide enough water for adult migration through the mainstem.

Dams have created total barriers to adult passage into Santa Paula and Piru Creeks. Sespe Creek remains accessible to adult migration.

Despite uncertainties about Vern Freeman Diversion and mainstem passage efficiencies, it appears that adult migration barriers would not severely impact restoration. The ladder at Vern Freeman together with available flows in the mainstem should offer adequate opportunity for fish passage to the currently available spawning areas.

Fishery exploitation

Fishery exploitation rates appear to be minimal. There is an ongoing trout fishery in many areas of the Santa Clara system. However, much of the spawning and rearing habitat in Sespe Creek is accessible only by hiking. The fishing pressure in this area should remain at a relatively low level.

Spawning and rearing habitat

The spawning and rearing habitat on Sespe Creek is thought to be in excellent condition. Sespe Creek is undeveloped and relatively inaccessible to humans. In April of 1988 a survey of about 10 miles of the lower Sespe found that, "Suitable steelhead spawning and rearing habitat is abundant." (Moore, 1988). It is estimated that Sespe contains 47 miles of spawning and rearing habitat, down from 53 miles historically (Moore, 1980). This represents approximately one half of the historical spawning and rearing habitat in the Santa Clara system.

Santa Paula Creek is moderately developed but still contains a substantial amount of good quality rearing habitat. Providing adult passage over the old diversion dam in Santa Paula Creek would open this area to steelhead production.

Piru Creek has lost large amounts of habitat to reservoirs and flow changes. A survey would be required to estimate the amount of habitat remaining.

Exotic Population Complications

In addition to rainbow trout plants, Prickly sculpin (Cottus asper), Black bullhead (Ameiurus melas), Largemouth bass (Micropterus salmoides), Green sunfish (Lepomis cyanellus), Bluegill (Lepomis macrochirus), and Bullfrog (Rana catesbeiana) have been introduced into the Santa Clara system (Mark Capelli, pers. comm.). Trout have been planted in Sespe starting in the 1940s. These introduced populations are all potential predators of steelhead and, in some cases, competitors for habitat. Additionally, if the rainbow population spawns at the same time and place as the steelhead, there may be some inbreeding between these stocks.

Since the introductions occurred some time ago, continued existence of the steelhead population suggests that there is some opportunity for co-existence. A major concern, however, is how the populations of exotic species would react to an increase in the steelhead population.

Juvenile Outmigration

Obstacles to juvenile outmigration are thought to be the major cause of the decline of the Santa Clara steelhead run. The most significant of these obstacles was the lower river diversion dam.

During years when the dam was unscreened, a high proportion of outmigrating juveniles were likely trapped in the percolation ponds.

Assuming that the juvenile passage facilities at the current Vern Freeman Diversion perform as designed, juvenile passage should be greatly facilitated. This should substantially increase juvenile survival rates, perhaps to a level sufficient to provide rebuilding of the run.

The decreased flows caused by the upper watershed dams continue to have some impact on migration. Again, it is very difficult to assess the extent of this impact. Certainly, some proportion of juveniles will migrate during freshets when flows in the mainstem are adequate. Problems may occur when smaller freshets, combined with upper watershed storage, do not provide adequate mainstem water for outmigration. Steelhead may become trapped in shallow drying pools in the mainstem.

Estuary Rearing

The estuarine conditions in the Santa Clara lagoon have changed dramatically over the past several decades. Levies, decreased river flows, and pollution have changed the lagoon environment (Jeff Price, pers. comm.). In particular, the natural frequency of lagoon breaching has been disrupted. Currently the lagoon is breached artificially when water levels are sufficiently high.

The historical use of the lagoon by steelhead and the effect of current conditions on steelhead survival has not been studied. Smith (1990) has shown that juvenile steelhead extensively utilize estuarine environments in central California streams. These results may also apply to southern California lagoons.

Any restoration effort should include surveying the lagoon for juvenile steelhead and, if steelhead are present, monitoring environmental conditions.

Ocean Rearing

In recent decades the ocean environment has supported many more southern California steelhead than at present. There is little reason to suspect that ocean conditions have changed to the extent that ocean survival would limit restoration efforts on Santa Clara steelhead.

Need for a Restoration Program

Screening the percolation intake on the current Vern Freeman Diversion is thought to have corrected the major cause of the declining Santa Clara steelhead run. The apparent correction of this problem can be expected to provide a substantial increase in the stock survival rate. It is far from apparent, however, if this improvement alone will provide increasing run sizes or even stabilize the current run size. Other survival limiting factors could have a more severe impact than is currently presumed.

There are numerous conditions that could limit or preclude natural rebuilding of the stock. Unfortunately most of these conditions can not be analyzed adequately because critical information is not available. Given the numerous unanswered questions, we cannot be confident that the current survival rate is stabilized. Additionally, the critically low run size adds to concerns of extinction. Taken together, these assessments argue for aggressive restoration in the short term together with surveys that will provide information needed to develop a long term restoration program.

Short Term Restoration

The very low run size calls for a restoration program designed to rapidly rebuild the run. The most effective method to accomplish this is a captive brood program. This consists of rearing steelhead in a controlled environment throughout their life cycle, from egg to spawned adult. Mortality at all life history stages is minimized.

A complete short term restoration program will require technical assessments, interagency agreements, and funding commitments that are not yet in place. Therefore, the following specifies the recommended short term program in general terms only.

Filmore Creek hatchery, on the Santa Clara River, has been suggested as a possible site for rearing steelhead. The California Department of Fish and Game (CDFG) currently produces rainbow trout at this facility and has expressed an interest in steelhead rearing, but a plan detailing production specifics and possible changes to the hatchery has not yet been developed. For the recommendations included here, we assume that resources for a moderately sized steelhead program will be available at Filmore hatchery. Saltwater facilities for captive brood would provide faster growth rates possible earlier maturation. The availability of saltwater facilities should be explored.

The adult fish trap at the Vern Freeman Diversion should be used to capture broodstock. This trap was not functional during 1991-1992 but is expected to be ready for the 1992-1993 season.

The number of steelhead to remove for restoration at Vern Freeman depends on a number of factors. First, if substantially more steelhead than expected enters the system (say 200 fish) then the need for artificial propagation should be reconsidered. In this case, any captured brood could be released in Sespe

Creek and the restoration program could be redirected toward natural rebuilding. If the number of returning steelhead falls below this number then determining the number to collect becomes more complex and requires assumptions about the availability of hatchery resources.

Genetic requirements specify a minimum program goal. The minimum number of spawners needed in the initial egg take is much debated, but 25 pairs is often cited. Therefore, at least 25 pairs should be acquired if available. If less than 25 pairs are available, the entire run should be taken. If more than 25 pairs are available then additional pairs should be taken until available hatchery capacity is reached.

When the captured adults are spawned, eggs from each pair should be included in the captive brood egg supply. The number of eggs needed will likely be a small fraction of the number collected. For example, 25 adult pairs would likely produce 50,000 eggs or more. A typically sized captive brood program of 500 to 1000 adults would require an initial supply of perhaps 1000 to 1500 eggs to allow for some mortality. The number of adults to maintain for this program will be determined by hatchery capacity, program goals, and opportunity for adult reuse. For example, how many times should each adult be reused, what is the rate of survival for spawned adults, how many juveniles should be planted for stock rebuilding, etc?

There are several options for utilizing production eggs obtained by the program (by production we mean eggs taken from Vern Freeman captures, or captive brood, that are in excess of the number needed to maintain the captive brood program). Given the objective of quickly rebuilding run size, an attractive option would be to hatch all eggs and rear the fish to smolt in the hatchery. When flows are optimum, the excess smolts could be released in Sespe Creek. This method should avoid most in-river sources of mortality. Another method would be to return the eggs to the river by using remote site incubators. This method would require less hatchery resources but would subject the juveniles to in-river causes of mortality.

Critical Information Needs

Development of a long term restoration program will require considerable information that is not yet available. The needed information includes:

- Assessment of the effectiveness of fish passage facilities at the Vern Freeman Diversion. This is scheduled to be studied. The study design is described in ,"Study Plan: Vern Freeman Diversion Project Fishery Mitigation Monitoring Study". Prepared for United Water Conservation District, 1991.

- Assessment of mainstem Santa Clara transportation efficiency. Do adults and/or juveniles tend to get caught in pools and suffer high mortality rates?

- Assessment of exotic species complications. What is the level of predation and competition between steelhead and exotic species? Of particular importance here is to monitor the change in exotic populations as the steelhead population increases. Also, monitor rainbow spawning schedules and locations.

- Monitoring of estuary conditions and steelhead use of the estuary.

FWS Interest in This Stock

FWS has a mandate to restore nationally significant depressed stocks and to provide fishing opportunities. Restoration of Santa Clara steelhead fits within both categories. The stock is significant because it is one of the last remaining Southern California steelhead stocks, all of which are at very low levels (Nehlsen, 1991). Historically, the Santa Clara stock supported a steelhead fishery. There are numerous reports in local newspapers of steelhead catches. A restored Santa Clara steelhead stock could provide a valuable fishery for this prized game fish.

Southern California steelhead represent a unique genetic resource. These stocks developed unique mechanisms to exist through periods of drought and generally arid conditions. Most Southern California river systems have water in the lower reaches only during periods of high flow. Steelhead have to opportunistically utilize these flows for both juvenile and adult migration between the ocean and upstream habitat. These southern races are thought to have relatively high straying rates, which aid them in finding and utilizing rivers that have sufficient flow during general drought conditions. They may have a high tolerance to warm water and low oxygen levels (Higgens, 1991). The unique characteristics of this stock make it a candidate for listing under the endangered species act.

Our experience with the Santa Clara system via Fish and Wildlife Coordination Act provides additional reasons for FWS interest in this stock. FWS has provided information and recommendations to the U. S. Corp of Engineers concerning water projects in the Santa Clara System. As part of this process FWS has acquired considerable expertise concerning the Santa Clara ecosystem including the steelhead stock. FWS personnel are recognized as experts in Santa Clara steelhead issues by personnel from other resource agencies.

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